
Hoofdsprekers:
Henry Cohn
Jos Leys
Konstantin Mischaikow
Ken Ribet (Brouwerlezing)
Nederlands
Mathematisch
Congres 53
11 & 12 april
2017
Utrecht

Program of Dutch Mathematical Congress 2017

Utrecht

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Carolin Kreisbeck (UU)
Johan van de Leur (UU)

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Cover design by Tom Goris
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Thanks

The organizers gratefully acknowledge support from:

Dear Participant,

Welcome to the 53rd Dutch Mathematical Congres which takes place under the auspices of the Koninklijk Wiskundig Genootschap on April 11 and 12, 2017 at the Koningsbergergebouw in the Uithof of Utrecht University. The local organization is in the hands of a team of mathematicians from Utrecht University.

The program has been composed by a national scientific committee and it includes plenary lectures by Henry Cohn, Jos Leys, and Konstantin Mischaikow. Semi-plenary lectures are given by Dion Gijswijt, Nelly Litvak, Natasha Maurits, and Bob Rink. Moreover, there will be seven minisymposia (GQT, STAR, Optimization, Scientific Computing, Rationals Points, NDNS+, Stieltjesprijs Symposium by Wonder) with invited speakers, as well as a poster session. Also, a special talk will be given by Jaap Korevaar, honorary member of KWG.

The Brouwer prize will be awarded to Kenneth Ribet who will give a plenary lecture at the conference on April 11 from 16:30 to 17:30. The evening program afterwards includes a reception at the Koningsbergergebouw and the conference dinner at the Academiegebouw.

On Wednesday morning April 12, five young researchers will give short presentations on their PhD research, thereby competing for the PhD prize. The prize ceremony will be at the closing ceremony of the congres.

The *Docentendag* on April 12 has been recognized as an official schooling activity for teachers (6RU, registration number y5FXed8yAU). The minisymposium of the docentendag focuses on *Achtergronden bij de nieuwe onderwerpen in het wiskundeprogramma voor de tweede fase.* It includes the awarding of the Pythagoras prize for the best high school final project in mathematics.

There will be the chance to visit the exhibition “Women in Mathematics”, which is hosted by Utrecht University in the period March 23 – April 14, 2017.

We hope you enjoy your participation and attend many exciting events during the congress!

Should you have any questions or encounter any problems please contact the registration desk.

The local organizers: Rob Bisseling, Carolin Kreisbeck, Johan van de Leur

Practical information

Location
All plenary and semiplenary lectures of NMC 2017 will take place at the Victor J. Koningsberger building (Budapestlaan 4a-b) in the Utrecht Science Park at The Uithof. Minisymposia will take place in the Buys Ballot building (BBG) next door which can be accessed directly from the Koningsberger building. The conference dinner in the evening of April 11 will be held in the Aula of Utrecht University Hall (Academiegebouw, Domplein 29) in the city centre next to the Dom. **Please make sure to bring your dinner ticket, which will be handed to you on 11 April at registration.**

Lunches, coffee and tea breaks
Lunches and coffee and tea are included in the registration fee. Lunches will take place in the Vagant (temporary building opposite the Koningsberger building). For participants in the KWG meeting (on Tuesday) and the MasterMath evaluation meeting (on Wednesday) there is a separate lunch close to the meeting place. Please stick to your specific lunch location to prevent overcrowding (and undercrowding!). Coffee and tea will be served next to the meeting rooms in the Koningsberger building.

Directions for public transportation
To reach the Utrecht Science Park, take bus 12 from Utrecht central station (the fastest option), or bus 28 from the city centre or central station. From other railway stations: Amersfoort (line 72), Bunnik (line 242), Bilthoven (line 31), Driebergen-Zeist (line 71, 271 and 371), Utrecht Overvecht (line 30) and Utrecht Lunetten (line 31). Busses ride directly to the Utrecht Science Park from Houten (line 281), IJsselstein (line 283) and Vianen (line 287).

Directions for bike and car
See the NMC 2017 website under *Directions and local information.*

Equipment
There is wireless internet available via eduroam. All lecture rooms are equipped with a blackboard, a computer and a beamer.

Stands
In the Koningsberger building, on the first floor next to the Pangea room, there will be stands of the following organisations. On Tuesday and Wednesday:

- Koninklijk Wiskundig Genootschap (KWG), together with Epsilon Uitgaven
- Elsevier
- Puzzlingworld
- Women of Mathematics throughout Europe

Only on Tuesday:

- Ortec

Only on Wednesday:

- Nederlandse Vereniging van Wiskundeleraren (NVvW)
- Pythagoras
- Kangoeroe
- Vierkant voor Wiskunde
- Optische Fenomenen
- Noordhoff

Program of NMC 2017

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Sonja Hohloch
Selman Akbulut
Jaap van Oosten</td><td>Mini 2: STAR BBG219
Julia Komjathy
Arnoud den Boer
Pasquale Cirillo
Peter van de Ven</td><td>Mini 3: Optimization BBG165
Nikhil Bansal
Etienne de Klerk
Neil Olver
Markus Schweighofer</td><td>Mini 4: Scientific Computing BBG161
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Arthur Bakker
Quintijn Puite
Pythagorasprijs</td></tr>
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Brouwer lecture by Kenneth Ribet (Tuesday 16:30-17:30 Cosmos)
Fermat's Last Theorem, Bernoulli numbers and Kummer's criterion
Brouwer laudatio and medal ceremony (Tuesday 17:35-17:50 Cosmos)

Photo: Gauri Powale

The Royal Dutch Mathematical Society (KWG) has awarded the Brouwer medal 2017 to the American mathematician Kenneth Alan Ribet, professor at the University of California, Berkeley.

This prestigious prize, installed in 1970 by the Royal Netherlands Academy of Arts and Sciences and the KWG in memory of Luitzen Egbertus Jan Brouwer (1881–1966), is awarded once every three years during the Dutch Mathematical Congress to a mathematician of international renown. This year the medal has been awarded to Kenneth Ribet for his contributions to number theory, in particular for the groundbreaking work in which he applies methods of algebraic geometry to number theoretical problems. This work later became of decisive importance for the proof of Fermat's Last Theorem.

Professor Ribet is a member of the American Academy of Arts and Sciences and of the National Academy of Sciences. Since 2017 he is president of the American Mathematical Society.

Abstract of the Brouwer lecture. Before the proof of Fermat's Last Theorem in the mid-1990s, algebraic number theory was the tool of choice in the study of the equation $a^n + b^n = c^n$. In fact, the entire subject of algebraic number theory emerged as a response to Fermat's claim about whole number solutions to this equation! In my talk, I will describe Fermat's analysis of this equation for $n = 4$ and then explain how Ernst Eduard Kummer developed analogous methods when n is a prime number bigger than 2. Kummer's work gave rise to "Kummer's criterion"that relates a factorization property in algebraic number theory to the numerical coefficients of the expansion of $\frac{x}{e^x-1}$ in terms of powers of x. A bit over forty years ago, I refined Kummer's criterion so that individual coefficients in the expansion are related to more precise factorization properties.

Previous Brouwer laureates are given in the following table.

year	**name**	**field of mathematics**
1970	R. Thom	topology
1973	A. Robinson	foundations
1978	A. Borel	Lie groups
1981	H. Kesten	probability theory
1984	J. Moser	analysis
1987	Y. Manin	number theory
1990	W. M. Wonham	control theory
1993	L. Lovász	discrete mathematics
1996	W. Hackbusch	numerical mathematics
1999	G. Lusztig	algebra
2002	M. Aizenman	mathematical physics
2005	L. Birgé	mathematical statistics
2008	P. A. Griffiths	geometry
2011	K. Plofker	history of mathematics
2014	J. N. Mather	dynamical systems

Abstracts of plenary lectures

Henry Cohn (Microsoft)
The sphere packing problem in dimensions 8 and 24 (Tuesday 9:45-10:35 Cosmos)

What is the densest packing of congruent spheres in Euclidean space? This problem arises naturally in geometry, number theory, and information theory, but it is notoriously difficult to solve, and until recently no sharp bounds were known above three dimensions. Last spring Maryna Viazovska found a remarkable solution of the sphere packing problem in eight dimensions. In this talk, I'll describe how her breakthrough works and where it comes from, as well as follow-up work extending it to twenty-four dimensions.

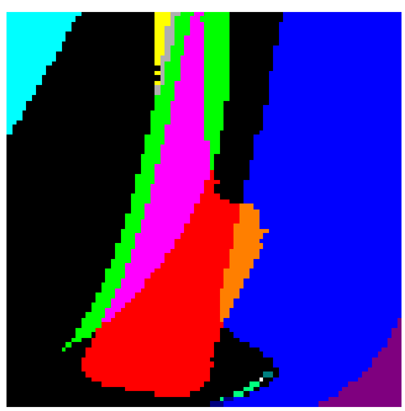
This is joint work with Kumar, Miller, Radchenko, and Viazovska.

Konstantin Mischaikow (Rutgers, The State University of New Jersey)
A combinatorial/algebraic topological approach to nonlinear dynamics
(Wednesday 9:30-10:20 Cosmos)

The current paradigm for nonlinear dynamics was introduced by H. Poincaré and explicitly formulated in the language of differential topology by S. Smale and R. Thom. It was developed to analyze physical systems with models given in terms of nonlinear equations and well-defined parameters with the goal of describing the behavior of a typical trajectory at a typical parameter value. The resulting theory is incredibly complex and has led to the understanding of extremely sensitive structures in both phase space (chaos) and parameter space (bifurcation theory).

However, with the advent of radically improving information technologies, science is being evermore guided by data-driven models and large-scale computation. In this setting, one often is forced to work with models for which the nonlinearities are not derived from first principles and quantitative values for parameters are not known.

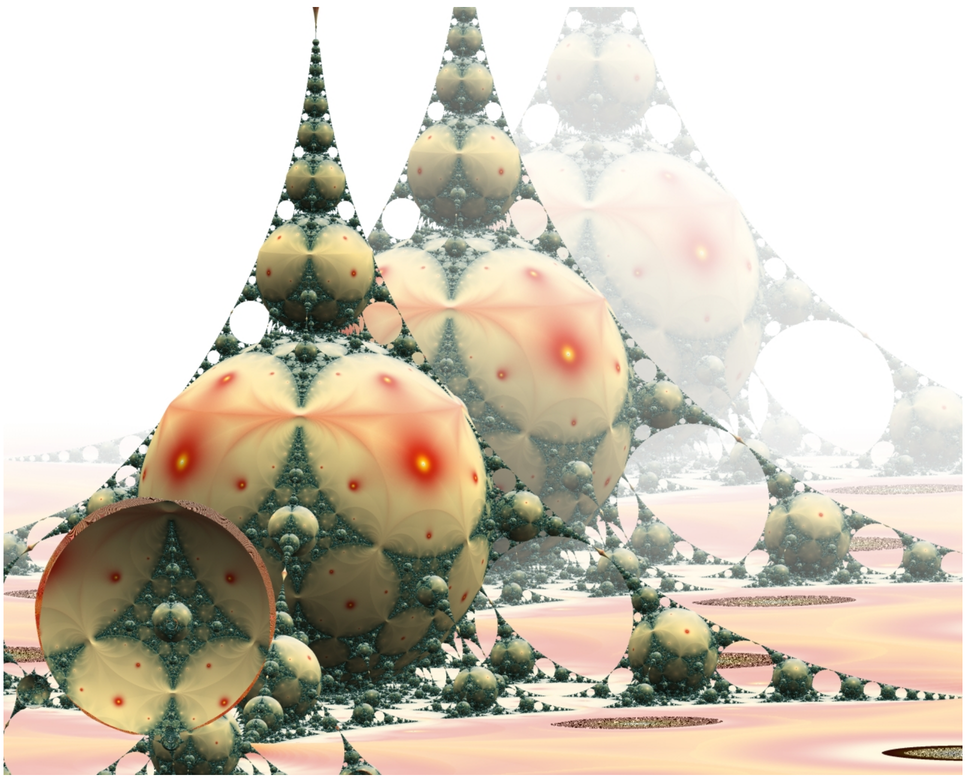
With this in mind, I will describe an alternative approach formulated in the language of combinatorics and algebraic topology that is inherently multiscale, amenable to mathematically rigorous results based on discrete descriptions of dynamics, computable, and capable of recovering robust dynamic structures. To keep the talk grounded, I will discuss the ideas in the context of modeling of gene regulatory networks.



Jos Leys
Fractals: from 2D to 3D (Wednesday 16:30-17:20 Cosmos)
`http://www.josleys.com`

Fractals in the plane, such as the Mandelbrot set, can generate beautiful images. However, when a third dimension is added, a whole new world opens up. Not so long ago the Mandelbulb and the Mandelbox were discovered, and these are both three-dimensional fractal objects. There are others, such as hybrid fractals.

In this talk, I will be showing nice examples of all of these, and will then concentrate on the search for the three-dimensional limit sets of Kleinian groups.



Additional events

Yearly meeting of the members of the KWG
Tuesday 12:15-13:15 Atlas

Founded in 1778, the Dutch Royal Mathematical Society (Koninklijk Wiskundig Genootschap) is the oldest of all present-day national mathematical societies. The society serves as professional organization of the Dutch mathematics community. Besides organizing conferences, it also issues journals and magazines like Indagationes Mathematicae, Nieuw Archief voor Wiskunde and Pythagoras. Together with the Dutch society of mathematics teachers, it participates in PWN (Platform Wiskunde Nederland). The society also represents the Dutch mathematical community internationally in the EMS and IMU. The yearly meeting of the Dutch Royal Mathematical Society is traditionally held during the NMC.

Mastermath evaluation meeting
Wednesday 13:00-13:30 BBG079

One of the action points mentioned in the Deltaplan Mathematics is to evaluate Mastermath. The results of this evaluation will be used as input for setting up a plan for a new structure for national collaboration in mathematics education and research. A questionnaire has been sent out in January to ask about opinions on various aspects of Mastermath. First results will be discussed in this meeting.

Members of the evaluation committee are Erik Koelink, Cor Kraaikamp, and Marieke Kranenburg.

Special talk by Jaap Korevaar
Wie en wat veel betekend hebben voor mijn ontwikkeling
Wednesday 15:30-16:00 BBG223

Reminiscences by Jaap Korevaar, born 1923, member of the KNAW since 1975, and honorary member of KWG since 1998 (in Dutch).

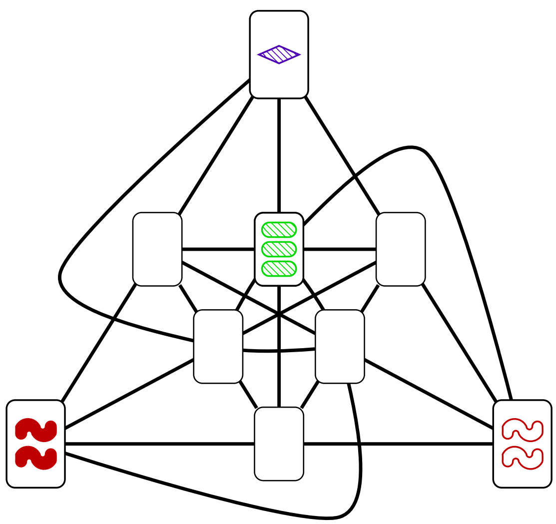
Abstract: Iemand die terugkwam uit Amerika kijkt terug. Fragmenten uit een boek 'Recollections' in ontwikkeling. Met wat eenvoudige wiskunde en anecdotes.

Abstracts of semiplenary lectures

Dion Gijswijt ((TU Delft)
Novel applications of the polynomial method in extremal combinatorics
(Tuesday 11:10-12:00 Cosmos)

A subset of $\mathbb{F}_3^n$ is called a *cap set* if it does not contain three vectors that sum to zero. In dimension four, this relates to the famous card game SET: a cap set corresponds to a collection of cards without a SET. The cap set problem is concerned with upper bounds on the size of cap sets. The central question raised by Frankl, Graham and Rödl is: do cap sets have exponentially small density?

Recently, this question was (very unexpectedly) resolved in a new application of the polynomial method. The proof is surprisingly short and simple. In this colloquium-style talk, we will explain the cap set problem and its resolution using the polynomial method. We will also survey the new developments of the past year.



Nelly Litvak (Universiteit Twente)
Influence and centrality in large networks (Tuesday 11:10-12:00 Atlas)

The problem of ranking network nodes by their influence or centrality has attracted a lot of attention. Most notably, Googles PageRank algorithm for computing importance of web pages revolutionized the web search. ther applications range from finding communities in social networks to predicting endangered species in food webs. In this talk, I will give a quick introduction to centrality measures and mathematical problems that arise from their analysis.

A part of the talk will be devoted to PageRank, which is a stationary distribution of a random walk with restart on a directed graph. I will show recent results on the distribution of PageRank in a class of random graphs, defined by the directed configuration model. The analysis involves coupling with branching processes, because the configuration model is locally tree-like. We will also discuss the first steps in investigating how the behaviour of PageRank changes when triangles and small communities, typical for real-life networks, are introduced in the model.

Another very interesting problem is discovering influential nodes when the structure of the network is unknown. This is a typical situation for many social networks, such as Twitter and Facebook, of which the complete graph obviously cannot be accessed or stored. Then the network structure can be discovered by crawling the network using its application programming interface (API). However, API allows only a limited number of requests per minute. I will present a randomized algorithm that finds top Twitter users with high precision using a very small number of API requests.

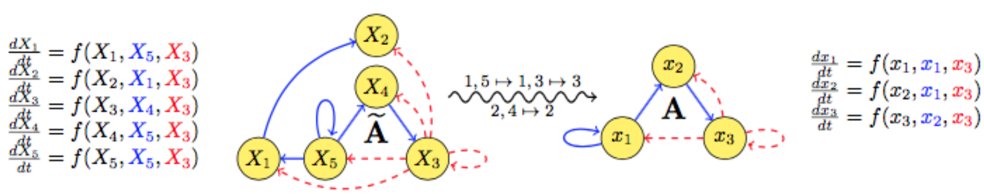
	Twitter users	Followers	Following	Tweets
1	KATY PERRY @katyperry	95,607,996	190	7,608
2	Justin Bieber @justinbieber	91,539,626	300,977	30,645
3	Barack Obama @BarackObama	84,088,937	631,665	15,434
4	Taylor Swift @taylorswift13	83,302,469	244	4,161
5	Rihanna @rihanna	69,480,199	1,134	9,898
6	YouTube @YouTube	66,399,134	986	18,768

Bob Rink (Vrije Universiteit)
Synchronisation in network dynamical systems (Wednesday 10:50-11:40 Cosmos)

Networks of coupled nonlinear dynamical systems arise as models throughout the sciences, and they often display unexpected phenomena. They may for example synchronise. This form of collective behaviour occurs when the agents of the network evolve in unison. Examples include bird flocks, and the simultaneous firing of neurons. It has also been observed that network synchrony often emerges and breaks through unusual bifurcation scenarios.

We discovered that these phenomena can be understood with the help of so-called graph fibrations. This observation led to a theory in which the representation theory of semigroups is used to compute and predict the local singular behaviour of network dynamical systems. Our long term aim is a classification of synchrony breaking bifurcations in networks.

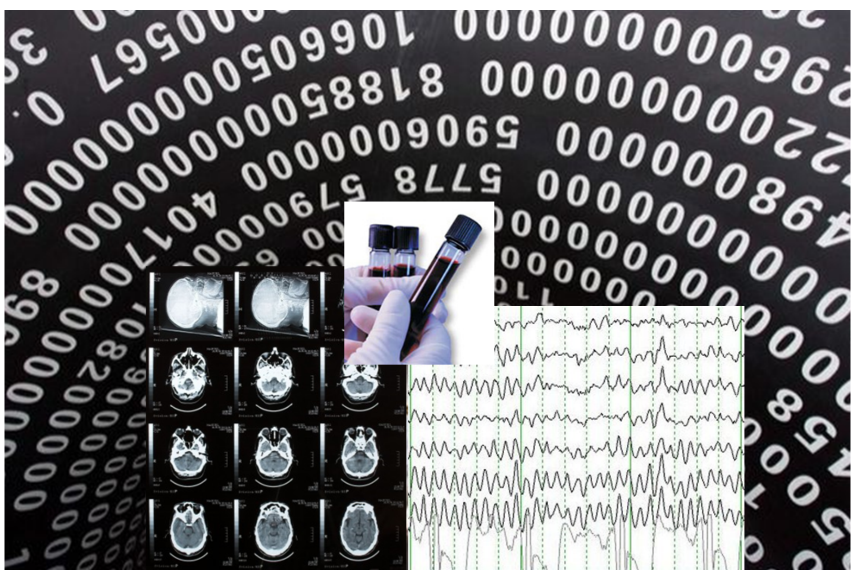
(This is joint work with Jan Sanders and Eddie Nijholt)



Natasha Maurits (UMC Groningen)
Patients in numbers: mathematics in neurology (Wednesday 11:40-12:30 Cosmos)
`http://www.clinicalneuroengineering.com`

No-one likes to be considered by their doctor as a number. However, in this lecture I will try to convince you that it is common for doctors to consider their patients in numbers and that this practice is actually very useful and helpful.

I will show that this practice can be supported and further improved with the help of mathematics by discussing some examples of my own research. You will see how image analysis and descriptive statistics can be used to improve the differential diagnosis of neuromuscular disorders, how spectral analysis can help to distinguish different forms of tremor and how principal component analysis is applied to tell different forms of impaired coordination apart.



Abstracts of session lectures

The scientific organizing committee has done its best to organize the sessions in such a way that they are thematically focussed. However, it is possible to switch between sessions, as they are globally synchronized, except for the session of PhD prize lectures.

Session 1, Tuesday 14:00-16:00, BBG223
cluster Geometry and Quantum Theory
Organizers: Gil Cavalcanti and Fabian Ziltener (Universiteit Utrecht)

Andreas Ott (Heidelberg University)
Asymptotics of Higgs bundles and hyperbolic geometry

I will compare gauge-theoretic (via Higgs bundles) and geometric (via hyperbolic geometry) compactifications of $SL(2, C)$ representation varieties.

This is joint work with Jan Swoboda, Richard Wentworth, and Michael Wolf.

Sonja Hohloch (Universiteit Antwerpen)
Recent new developments in semitoric integrable Hamiltonian systems

A semitoric integrable Hamiltonian system, briefly a semitoric system, is given by two autonomous Hamiltonian systems on a 4-dimensional manifold whose flows Poisson-commute and induce an $S^1 \times \mathbb{R}$-action that has only nondegenerate, nonhyperbolic singularities. Semitoric systems have been classified a couple of years ago by Pelayo and Vu Ngoc by means of 5 invariants. Two of them, the Taylor series invariant and the twisting index, have proven so far difficult to compute. Nevertheless, we managed to calculate the Taylor series invariant for coupled angular momenta (and hopefully by the date of this talk also for coupled spin oscillators).

This talk is based on a joint work with J. Alonso Fernandez and H. Dullin.

Selman Akbulut (Michigan State University)
Exotic smooth structures on 4-manifolds

Major open problems of smooth 4-manifolds are mostly centered around finding exotic copies of small manifolds, such as S^4, $S^2 \times S^2$, $\mathbb{CP}^2$, $S^1 \times S^3$. In this talk, I will briefly survey what's known so far, and show the pictures of the smallest known exotic manifolds (exotic copies of a contractible manifold and a twice blown up projective space), and discuss the fundamental "atomic"pieces of 4-manifolds (corks, plugs, anti-corks) which make them exotic.

Jaap van Oosten (Universiteit Utrecht)
Topological models of Computability

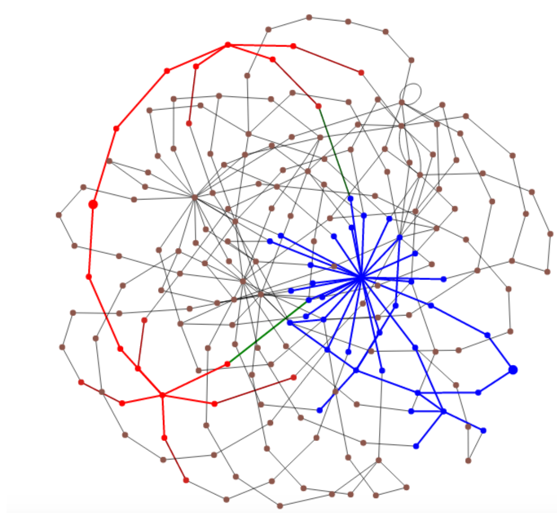
The notion of a 'computable function' on the natural numbers goes back to Turing (1936) and is robust and stable. Once one considers functions defined on the powerset of the natural numbers, or on the set of all functions from integers to integers, notions of 'computability' are less straightforward, but one interpretation is: continuous for a given topology. We discuss the abstract definition behind this and some examples, where we also treat Turing's notion of 'relative computability': a function f is computable relative to a function g if f is computable, once g is 'given to us by an oracle'.

This is joint work with Niels Voorneveld.

Session 2, Tuesday 14:00-16:00, BBG219
cluster Stochastics: Theoretical and Applied Research
Organizers: Bert Zwart (CWI) and Frank den Hollander (Universiteit Leiden)

Julia Komjathy (Eindhoven University of Technology)
When are scale-free graphs ultra-small?

Real life networks often have *truncated power-law* empirical degree distributions. That is, the probability that a uniformly chosen vertex has degree at least x behaves as $x^{1-\tau}$ up to some truncation point T_n that depends on the size of the network. In this talk, we investigate how the truncation value T_n affects the graph distances.



We determine the graph distance between two uniformly chosen vertices in a popular model for real life networks, the configuration model: we show that when there are n vertices and the truncation is at $T_n = n^{\beta_n}$, the first and second order terms are $\mathcal{O}(\log\log n)$ and $\mathcal{O}(1/\beta_n)$, respectively (whichever the larger of the two) and the third order terms are tight random fluctuations.

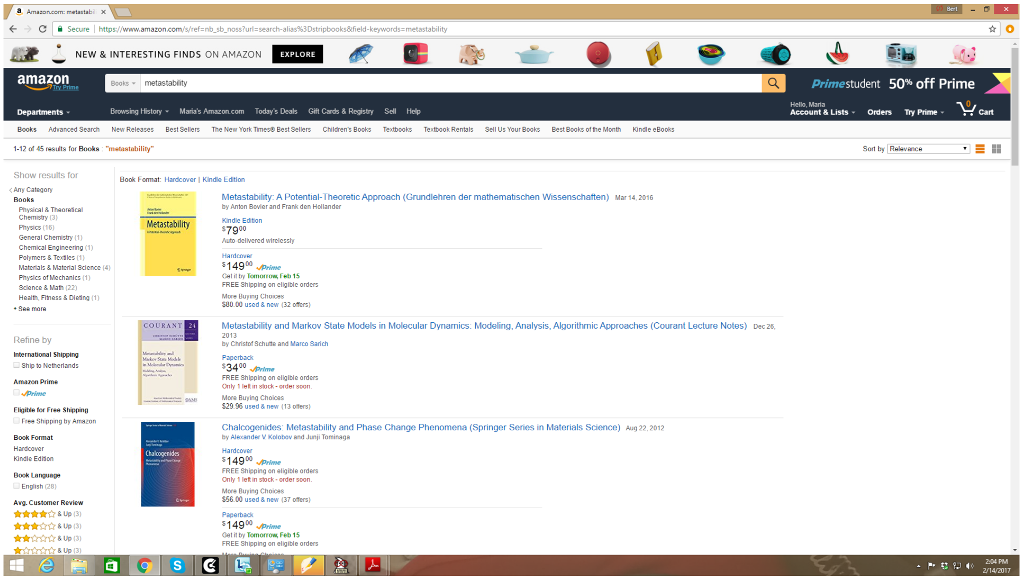
Our theorems also apply when we study the effect of a deliberate attack on distances in the network: a deliberate attack is when we remove every vertex with degree at least T_n and the edges attached to these vertices from the graph. These results clarify some debate in the physics literature about typical distances in locally-tree like random graphs in the infinite variance regime.

This is joint work with Remco van der Hofstad.

Arnoud den Boer (Universiteit van Amsterdam)
Best Buys and Discontinuous Demands

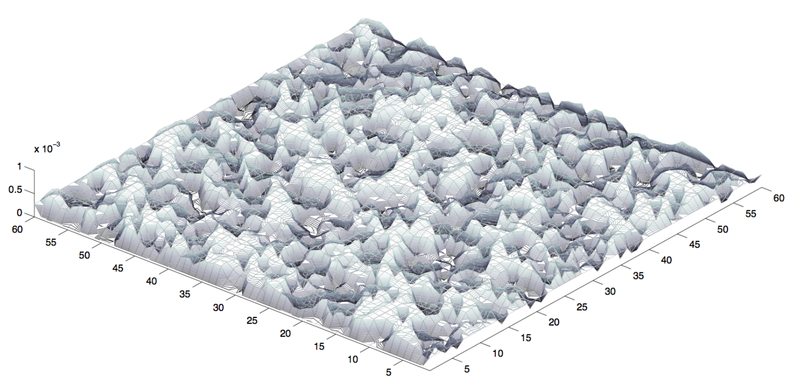
We consider a dynamic pricing problem with an unknown and discontinuous demand function. There is a seller who dynamically sets the price of a product over a multi-period time horizon. The expected demand for the product is a piecewise continuous and parametric function of the charged price, allowing for possibly multiple discontinuity points. The seller initially knows neither the locations of the discontinuity points nor the parameters of the demand function, but can infer them by observing stochastic demand realizations over time. We measure the sellers performance by the revenue loss relative to a clairvoyant who knows the underlying demand function with certainty. We first demonstrate that ignoring demand discontinuities in dynamic pricing can be extremely costly. Then, we construct a dynamic estimation-and-pricing policy that accounts for demand discontinuities, derive the convergence rates of discontinuity- and parameter-estimation errors under this policy, and prove that it achieves near-optimal revenue performance. We also extend our analysis to the cases of time-varying demand discontinuities and inventory constraints.

This is joint work with N. Bora Keskin



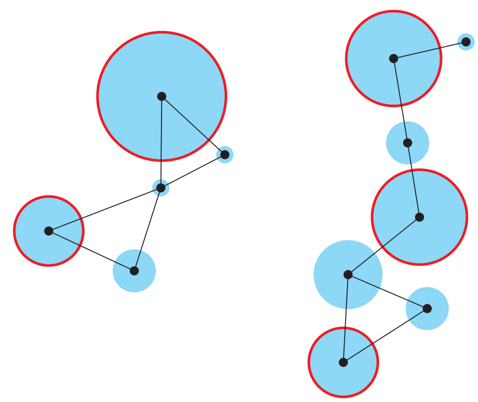
Pasquale Cirillo (TU Delft)
Interacting urn systems

In this talk, I deal with a special class of combinatorial stochastic processes built by means of interacting urns, that is to say sets of"boxes and balls"whose sampling schemes and compositions may depend temporally, spatially or both. I review some basic constructions, from RUPs to ISS, describing their probabilistic and statistical properties, and showing how these models can be used in modeling very different phenomena, from financial fragility to inter banking networks, from solar sunspots to tumors' growth.



Example of the joint distribution over the lattice

Peter van de Ven (CWI)
Stochastic models for random-access wireless networks

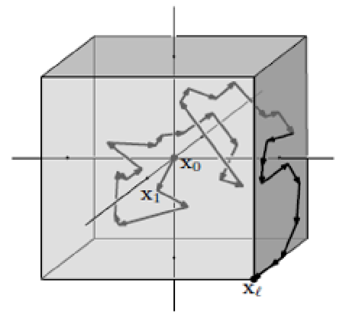


Random-access algorithms provide a popular mechanism for distributed control in large-scale wireless networks. We study the performance of these networks using a model of interacting queues on a graph. These networks may exhibit severe unfairness, in the sense that some nodes receive consistently higher throughput (fraction of time transmitting) than others. We study this unfairness, and adapt the nodes aggressiveness to remove the unfairness completely. These models primarily pertain to a saturated scenario where nodes always have packets to transmit. In reality however, the buffers may occasionally be empty as packets are randomly generated and transmitted over time. The resulting interplay between the activity states and the buffer contents gives rise to quite complicated dynamics, and even establishing the stability criteria is usually a serious challenge. We discuss how mean-field limits can be used to gain a better understanding of unsaturated multi-hop networks, where packets are forwarded between nodes.

Session 3, Tuesday 14:00-16:00, BBG165
Optimization
Organizer: Monique Laurent (CWI)

Nikhil Bansal (Eindhoven University of Technology)
Optimization and algorithmic discrepancy

Combinatorial discrepancy is a widely studied area with several applications in geometry, algorithms, complexity theory, and combinatorics. While there has been remarkable progress in recent years on the algorithmic aspects of discrepancy, the bounds based on the so-called Banasczcyk's method seemed out of reach. I will describe a recent algorithmic approach based on semidefinite optimization and random walks that allows us to match Banaszczyk-based bounds for many classic problems.



Based on joint works with Daniel Dadush and Shashwat Garg.

Etienne de Klerk (Tilburg University and Delft University)
On the worst-case performance of the optimization method of Cauchy for smooth strongly convex functions

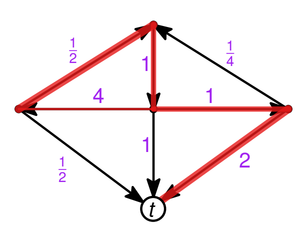
We consider the Cauchy (or steepest descent) method with exact line search applied to a strongly convex function with Lipschitz continuous gradient. We establish the exact worst-case rate of convergence of this scheme, and show that this worst-case behavior is exhibited by a certain convex quadratic function. We also give a worst-case complexity bound for a noisy variant of the gradient descent method. Finally, we show that these results may be applied to study the worst-case performance of Newton's method or the minimization of self-concordant functions.

The proofs are computer-assisted, and rely on the resolution of semidefinite programming performance estimation problems as introduced in the paper [Y. Drori and M. Teboulle. Performance of first-order methods for smooth convex minimization: a novel approach. *Mathematical Programming*, **145**(1-2):451-482, 2014].

This is joint work with F. Glineur and A.B. Taylor.

Neil Olver (Vrije Universiteit Amsterdam)
A faster and simpler strongly polynomial algorithm for generalized flow maximization

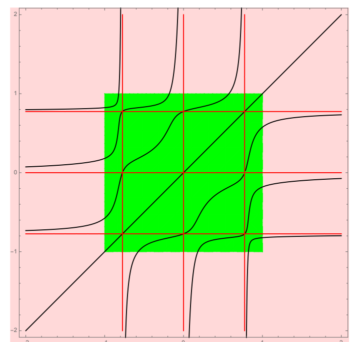
The maximum generalized flow problem is a very classical one in the theory of optimization. The goal is to maximize the amount of flow arriving at a specific sink node of a given network, but unlike with the standard maximum flow problem, flow may be scaled as it traverses an arc. (Imagine a network of leaky pipes, where some fraction of the fluid is lost as it passes through a pipe.)



There has been a large amount of algorithmic work on this problem in the past few decades. Only very recently, Végh gave a *strongly polynomial* algorithm, meaning that the number of arithmetic operations required depends polynomially on the size of the network, and not in any way on other parameters (such as edge capacities and scaling factors). This result is particularly important because the existence of a strongly polynomial algorithm for general linear programming is a major open question in optimization, and this result represents the boundary of our knowledge.

I will discuss recent work with L. Végh where we give a dramatically simpler, and also faster, strongly polynomial algorithm for the problem.

Markus Schweighofer (University of Konstanz)
On optimization problems whose solutions lead to quadrature rules with few nodes



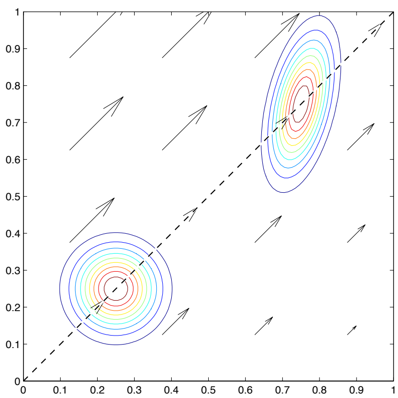
We consider several optimization problems whose feasible solutions encode generalized quadrature rules for measures on $\mathbb{R}^n$. We analyze these problems and their duals by the means of non-smooth analysis, by optimality and duality theory of conic optimization, and by real algebraic geometry. By various specific choices of the objective function, we manage to find optimal solutions to these problems that often provide quadrature rules with few nodes for a given measure. In this way, we find new interesting characterizations for Gaussian quadrature rules in one dimension. Next we generalize Gaussian quadrature from the real line to arbitrary plane algebraic curves. We prove an upper bound on the number of nodes needed for cubature rules on the plane that depends on the degree of exactness but not on the given measure. It seems to be the first non-trivial upper bound available for any degree which is valid for any measure on the plane. Finally, we find nice geometric proofs for results of Curto and Fialkow as well as of Curto and Yoo on the quartic cubature problem.

This is joint work with Cordian Riener.

Session 4, Tuesday 14:00-16:00, BBG161
Scientific Computing
Organizer: Rob Bisseling (Universiteit Utrecht)

Willem Hundsdorfer (CWI and Radboud University Nijmegen)
Multirate and Partitioned Runge-Kutta Schemes for Conservation Laws

In this talk, we will discuss explicit multirate one-step schemes for conservation laws and convection-dominated problems. Different regions of the spatial PDE domain may then have different (local) time steps. Such schemes can be conveniently represented as partitioned Runge-Kutta methods.



It is known that standard Runge-Kutta methods may suffer from order reduction when used as time stepping scheme for a PDE with boundary conditions. For multirate schemes, the interfaces act as time-dependent boundary conditions.

Theoretical results will be presented on the order of accuracy of some interesting multirate schemes, with cell-based and flux-based decompositions, together with numerical illustrations.

Albert-Jan Yzelman (Huawei Research France)
Bridging Scientific Computing and Big Data

Within the scientific computing community, the availability of supercomputers and major scientific challenges in physics, chemistry, and other fields have long driven the development of high performance software for applied mathematics. At the Huawei Paris Research Centre for Parallel Computing, our interest instead is in high performance algorithms usable for extracting knowledge out of the large volumes of data our current information age is making available.

In this talk, we sketch our approach in the specific case of graph computing and graph analytics. Using two common and widely-known graph queries and algorithms, we show how to express these computations as basic linear algebra operations over generalised semirings. The GraphBLAS provides this abstraction in a way that delivers just enough information for the resulting code to be 1) scalable, 2) highly efficient, and 3) transportable. We furthermore discuss some of the techniques we use to achieve highly scalable and efficient sparse matrix and graph computations.

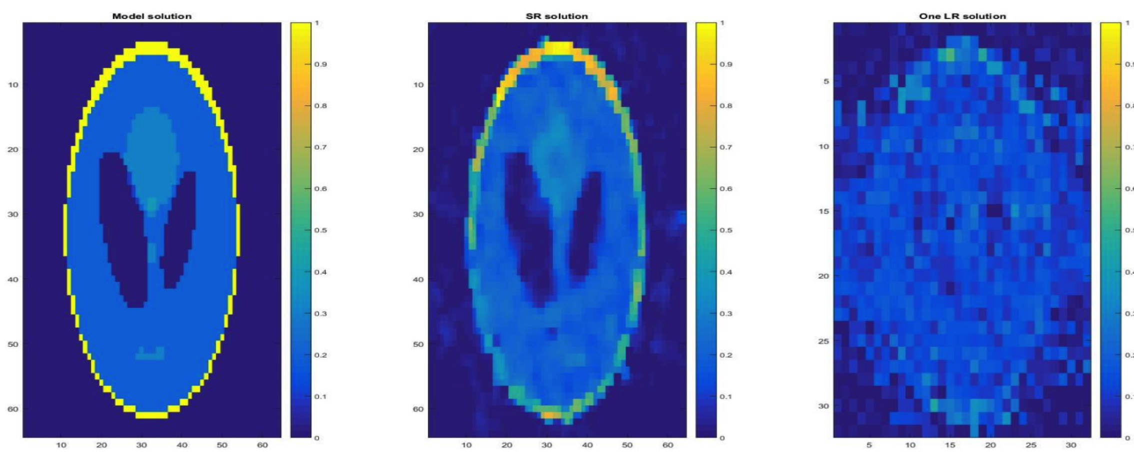
Martin van Gijzen (TU Delft)
Algorithms for low-field Magnetic Resonance Imaging

Conventional MRI scanners work by generating a very strong magnetic field using a superconducting magnet. A high-resolution image is computed essentially in real time by an inverse Fourier transform. Superconducting magnets, however, make MRI scanners costly to purchase, to install, and to maintain. Because of these reasons, MRI scanners are often out of reach in developing countries.

An alternative is to use permanent magnets. These are cheap, and do not require maintenance. The magnetic field, however, will be inhomogeneous and much weaker. As a result, the image reconstruction problem is much more complicated than for conventional MRI scanners.

The image reconstruction problem can be formulated as a large ill-posed least-squares problem. In the talk we will explain the mathematical and computational difficulties of this problem, and discuss a number of numerical linear algebra algorithms that can be used to solve it. We will also discuss how to enhance the image quality with super-resolution techniques, by combining a number of low-resolution images to one high-resolution image. The figure gives an example for simulated data.

This is joint work with Merel de Leeuw den Bouter (TU Delft), Rob Remis (TU Delft), Andrew Webb (LUMC) and Steven Schiff (Penn State University).



Left: model solution, Middle: super-resolution reconstruction from four low resolution images, Right: low resolution image

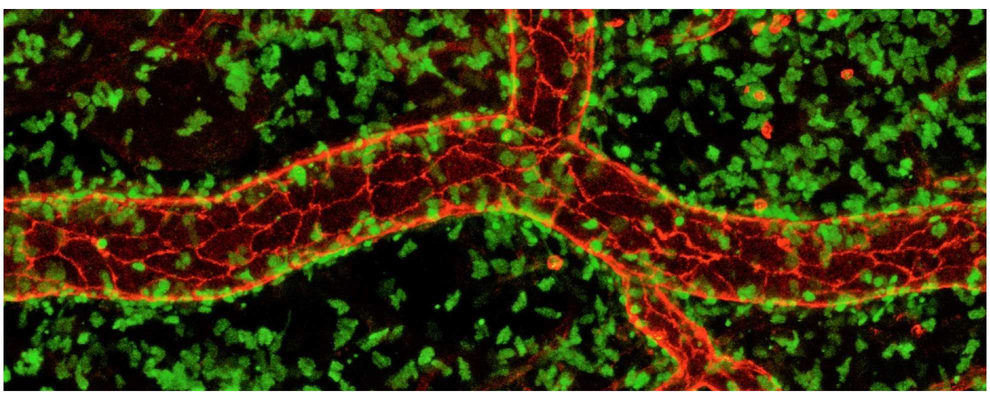
Cristoph Brune (Universiteit Twente)
Learning variational methods for inverse problems in 4D imaging

This talk addresses nonlinear reconstruction methods for inverse problems in mathematical imaging. I focus on two state-of-the-art challenges in the field, which play a fundamental role in 4D mathematical imaging for health and life sciences, namely: (1) learning variational methods and (2) solving dynamic inverse problems.

(1) To infer reliable information from large-scale imaging experiments, novel modeling techniques and variational inversion methods are needed. Computational learning and optimization of models are essential. I discuss our recent results on learning variational methods based on nonlinear regularization and nonstandard spectral decompositions.

(2) For the challenge of complex dynamic inverse problems, a new mathematical model and numerical algorithm for joint reconstruction and optimal transport theory subject to uncertain geometries is presented.

I will highlight new opportunities for scientific computing and show large-scale 4D data sets from cell biology (see blood vessel in figure) which illustrate the usefulness of the proposed reconstruction methods for mathematical imaging science.



Session 5, Wednesday 14:00-15:30, BBG223
Rational points (cluster DIAMANT)
Organizer: Bas Edixhoven (Universiteit Leiden)

Samir Siksek (University of Warwick)
Rational Points on Cubic Hypersurfaces

A cubic hypersurface S (defined over the rational numbers) of dimension n is an equation of the form $f(x_0, x_1, \ldots, x_{n+1}) = 0$ where f is a homogeneous cubic polynomial with rational coefficients. We are interested in understanding the set of rational solutions. A simple tangent and secant process, known to Diophantus, allows us to generate new rational points from old ones. The celebrated Mordell–Weil theorem is concerned with dimension $n = 1$ and asserts that there is a finite set of rational points that generate all others. A long-standing open question is whether the analogue of the Mordell–Weil theorem holds in dimension $n \geq 2$. We sketch a positive answer to this question for $n \geq 48$.

This is joint work with Stefanos Papanikolopoulos.

Steffen Müller (Universität Oldenburg)
Computing rational (or integral) points on hyperelliptic curves using p-adic integration

Let $f \in \mathbb{Z}[x]$ be a polynomial without repeated roots whose degree d is odd and at least 5. Then the diophantine equation $y^2 = f(x)$ has only finitely many rational solutions. From a geometric point of view, these solutions correspond to rational points on the algebraic curve C defined by the equation. In general it is a rather difficult problem to compute the set of rational points on a given curve. However, Chabauty's Theorem, made explicit by Coleman, implies that this should be possible using p-adic integration whenever the rank r of the Mordell-Weil group of the Jacobian variety of C, a finitely generated abelian group, is less than $(d-1)/2$. A research program initiated by Kim attempts to extend this to cases where this condition is not satisfied. After introducing the method of Chabauty and Coleman, I will discuss joint work with Jennifer Balakrishnan, Amnon Besser and Netan Dogra which makes some aspects of Kim's philosophy explicit and can often be used to compute the rational, or at least the integral, points on C when $r = (d-1)/2$.

Martin Bright (Universiteit Leiden)
Rational points in families of varieties

Given a polynomial equation in several variables, a fundamental number-theoretical question one can ask is whether the equation has any solutions in rational numbers. If the coefficients of the equation are allowed to vary, then this binary question becomes a quantitative one: how often does the equation have rational solutions? This corresponds to looking at a family of algebraic varieties, and asking how many varieties in the family admit a rational point.

A necessary condition for a variety to have a rational point is that it be *locally* soluble, that is, soluble over every completion of the rational numbers, real and p-adic. A natural approach to the above question is therefore first to ask about the proportion of varieties in the family that are locally soluble. Whether local solubility implies solubility in $\mathbb{Q}$ is the much-studied subject of the *Hasse principle*. For example, quadrics (varieties defined by a single equation of degree 2) always satisfy the Hasse principle, so studying local solubility is sufficient to completely understand solubility in $\mathbb{Q}$. On the other hand, there are obstructions to the Hasse principle, such as the *Brauer–Manin obstruction*, and so we are led to study how these obstructions behave in families of varieties.

I will give a survey of past work on this topic and present recent results on the Brauer–Manin obstruction to the Hasse principle in certain families of varieties.

Session 6, Wednesday 14:00-15:30, BBG219
Earth & Life (cluster NDNS+)
Organizer: Alef Sterk (Rijksuniversiteit Groningen)

Hil Meijer (Universiteit Twente)
On finding abnormal nodes in brain networks

For patients with refractory epilepsy, it is crucial to determine abnormal brain areas as it may allow brain surgery to remove these areas. Intracranial EEG data from electrode grids may guide such identification. We model the electrodes as a network of stochastic bi-stable oscillators with diffusive coupling. Then we systematically study such networks with four nodes. We find that some nodes act as a driver of epileptiform activity. Removal of this node then leads to a reduction in seizure rate, and this may be a better strategy than removing nodes that are more pathological.

Next, we explore a computational modelling approach where we use a patient-specific model to simulate which nodes first exhibit epileptiform activity. First, we construct networks based on intracranial EEG from patients. Using cross-correlations between activity of nodes we obtain a non-directional network. We find strong correlations mainly between nearby electrodes. We also create a directional network using evoked responses from Single Pulse Electrical Stimulation (SPES). We compare simulation results for two patients for both networks with actual clinical classification.

This is joint work with Geertjan Huiskamp and Frans Leijten (Neurology, UMC Utrecht) and J. Hebbink and S.A. van Gils (University of Twente).

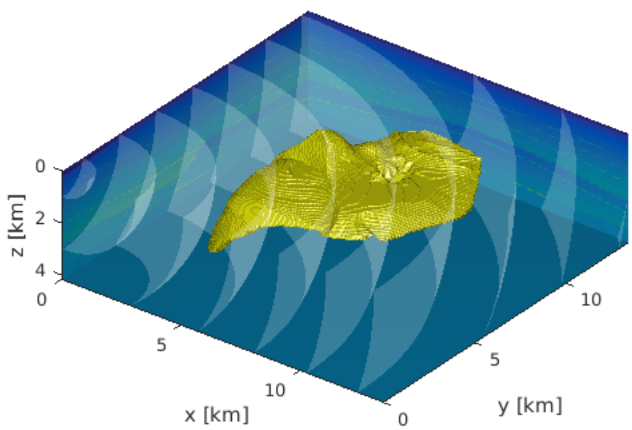
Dirk van Kekem (Rijksuniversiteit Groningen)
Travelling waves and their bifurcations in the Lorenz-96 model

In his 1996 paper, Edward Lorenz introduced a simple model to study fundamental issues regarding the predictability of the atmosphere and weather forecasting. The simplicity of this model makes it attractive and useful for various applications. The dimension n of the state space is a free parameter. We explored the dynamics of the monoscale Lorenz-96 model for any $n \geq 1$ and positive forcing parameter F using both analytical and numerical means.

In this talk, we show the main analytical result: the existence of Hopf or Hopf-Hopf bifurcations in any dimension $n \geq 4$. The first Hopf bifurcation for $F > 0$ is always supercritical and the periodic orbit born at this bifurcation has the physical interpretation of a travelling wave. Furthermore, to unfold the Hopf-Hopf bifurcation an extra parameter is added via a Laplace-like diffusion term. This two-parameter system explains the behaviour near a Hopf-Hopf point, such as quasi-periodic attractors and multistability, which are also observed in the original Lorenz-96 model. Finally, we will comment on some bifurcations of the periodic orbits and routes to chaos.

Tristan van Leeuwen (Universiteit Utrecht)
Large-scale inverse problems in seismology

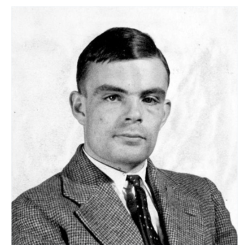
Detailed maps of subsurface rock properties can be estimated from seismic observations by solving a non-linear inverse problem. Applications of this technique include archeology, civil engineering, oil and gas exploration and earth-sciences. The inverse problem can be cast as a non-linear optimization problem that aims to fit observed to modelled data. To ensure a unique solution, regularization is required. Even when the solution is unique, it may be hard to find due to the non-linearity of the problem. In this talk, I will give an overview of some recent developments that address these issues. These include advanced regularization for geometric inverse problems and constraint-relaxation to convexify the optimization problem.



Session 7, Wednesday 14:00-15:30, BBG165
Stieltjesprijs Symposium on Computability, Complexity and Randomness
Organizer: Jason Frank (Universiteit Utrecht)

Sebastiaan Terwijn (Radboud Universiteit)
Computability Theory

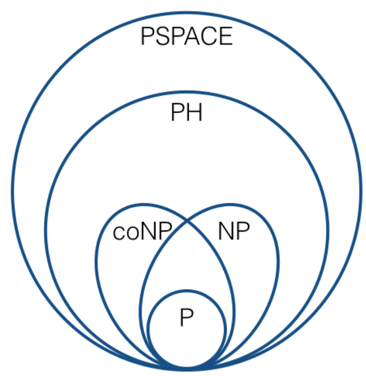
Computability Theory studies how computable or noncomputable mathematical problems and objects are, and tries to classify them accordingly. Central is the notion of Turing reducibility, that can be used to quantify how computable a set is by considering relative computability. This leads to the study of the Turing degrees, which is a structure with many intricate properties. There are several connections between computability theory and analysis. Effectivizing measure theory leads to the notion of algorithmic randomness, which is a useful tool in the study of Turing degrees, but also has applications in other areas. Second, it is possible to generalize the Turing degrees from sets of natural numbers to sets of reals. The resulting notions of Medvedev and Muchnik reducibility are useful in studying questions about uniformity, and also give interesting connections with areas such as constructive logic and proof theory.



Alan Turing

Ronald de Wolf (CWI/UvA)
Computational complexity theory

Some computational problems are easy to solve, for instance sorting, matching, linear programming; but many other computational problems are hard, for instance the Traveling Salesman Problem (TSP, which probably requires exponential time to solve) or the halting problem (unsolvable). Computational complexity theory tries to systematically classify computational problems n terms of the amount of resources that are required to solve them, such as the required amount of time or space. This leads to the definition of complexity classes, like P, NP, PSPACE, and the study of the relations between them.



Many things are unknown; the most famous is the so-called P vs NP problem. Roughly speaking, this asks whether the ability to efficiently *check* the solution to a given computational problem implies the ability to efficiently *find* such a solution. Or, for mathematicians, whether the ability to efficiently *check* a given proof of a theorem implies the ability to efficiently *find* such a proof. If P and NP are different classes (as most people believe), then problems like TSP and proof-finding are intrinsically hard.

In the last part of the talk we will briefly discuss a number of approaches to deal with hard computational problems, including randomized algorithms, approximation algorithms, average-case complexity, and quantum computers.

Rutger Kuyper (University of Wisconsin-Madison), Laureate Stieltjes prize

An introduction to algorithmic randomness

What does it mean for an infinite sequence of zeroes and ones to be "random"? For example, the sequence

$$0101010101010101010101\ldots$$

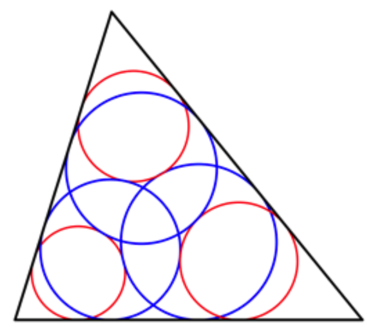
does not look random at all, while the sequence

$$0010010111010101010101\ldots$$

does look random. How can we make this intuitive notion of "randomness" mathematically rigorous? We will discuss several possible formalisations of this concept, with our main focus being Martin-Löf randomness. Martin-Löf randomness has many equivalent definitions, lending to its credibility, of which we will discuss several. Furthermore, we will discuss how randomness interacts with computation: how much extra computational power does access to true randomness give you?

Docentendag, Wednesday 14:00-16:00, BBG161 Achtergronden bij de nieuwe onderwerpen in het wiskundeprogramma voor de tweede fase
Organisatoren: Michiel Doorman (Universiteit Utrecht) en Derk Pik (Universiteit van Amsterdam, JSG Maimonides en Pythagoras)
Er zijn drie lezingen van elk dertig minuten. Tevens vindt de uitreiking van de Pythagorasprijs voor het beste profielwerkstuk in de wiskunde plaats.

Jeroen Spandaw (TU Delft)
Meetkunde DOEN



Zelf wiskunde (her)ontdekken is lastig, maar veel leuker dan andermans sommetjes maken met voorgeschreven methoden. In de meetkunde kan iedereen met behulp van Sangakus tot op zekere hoogte ervaren hoe het is om wiskundig onderzoeker te zijn. Startend met een prachtig plaatje ga je zelf op zoek naar een passend vermoeden, naar geschikte technieken om het probleem aan te pakken, naar een liefst elegant bewijs en naar de ultieme formulering van je eigen pareltje. In deze presentatie maakt u kennis met deze filosofie die in het onderwijs een mooie plek kan krijgen bij analytische meetkunde. We geven speciale aandacht aan de keuze van de meetkundige techniek(en). Uiteraard krijgt u vele mooie en uitdagende Sangakus voorgeschoteld. Na de voordracht kunt u ze zelf ook maken bij uw eigen meetkundig onderzoek!

Arthur Bakker (Universiteit Utrecht)
Wanneer is een statistisch significant verschil betekenisvol? De zin en onzin van effectgroottes.

Een van de nieuwe onderwerpen in het statistiekprogramma is de vraag of een statistisch significant verschil groot is. Om die vraag te beantwoorden zijn effectgroottes nuttige maten, maar zoals onderstaand fragment uit het examenblad voor havo-A laat zien, kan de invoering van nuttige statistiek ook leiden tot onzin. Terecht vragen docenten zich af waar onderstaande criteria vandaan komen. In deze presentatie ga ik in op de zin en onzin van effectgroottes. Dit onderwerp dient ook als illustratie van de dilemmas die rijzen als statistiek gedidactiseerd moet worden.

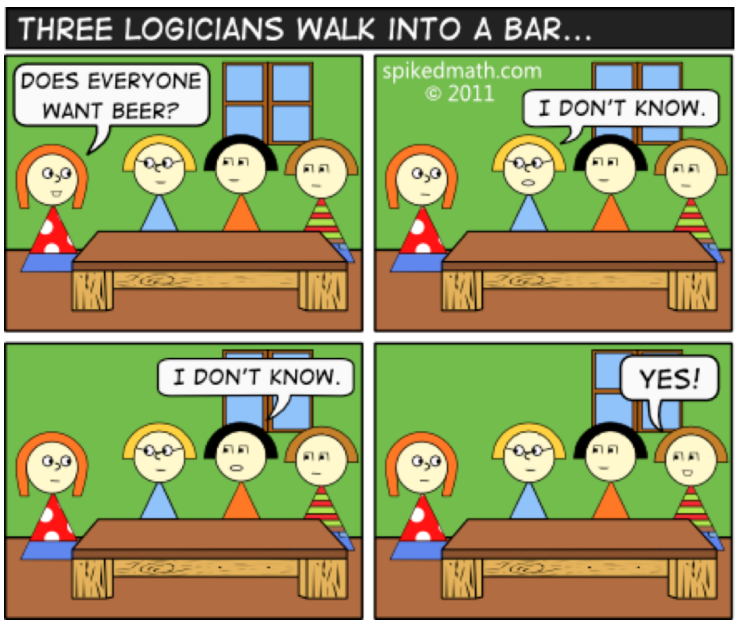
Effectgrootte $E = \dfrac{\overline{X}_1 - \overline{X}_2}{\frac{1}{2}(S_1 + S_2)}$, met $\overline{X}_1$ en $\overline{X}_2$ de steekproefgemiddelden ($\overline{X}_1 \geq \overline{X}_2$), S_1 en S_2 de steekproefstandaardafwijkingen

- als $E > 0{,}8$, dan zeggen we "het verschil is groot",
- als $0{,}4 < E \leq 0{,}8$, dan zeggen we "het verschil is middelmatig",
- als $E \leq 0{,}4$, dan zeggen we "het verschil is gering".

Fragment uit het formuleblad havo-A (2016)

Quintijn Puite (Hogeschool Utrecht)
Logisch redeneren bij wiskunde C vwo

Binnen de wiskunde komt logisch redeneren veel voor. Maar ook de politiek of de rechtspraak kunnen niet om logica heen. Sterker nog: in alle geledingen van de maatschappij is zuiver redeneren eigenlijk een onmisbaar goed. Want waarom zijn sommige dingen "logisch", terwijl je van andere dingen weet dat ze ëcht niet kunnen"? Het nieuwe examenprogramma van wiskunde C voor het VWO dat in september 2015 van start is gegaan, bevat het domein Logisch redeneren. We bekijken voorbeelden van lesmateriaal en pilot-examenopgaven die een duidelijk beeld geven van wat dit nieuwe domein behelst en welke kanten je hier in de les mee op kan.



Voorzitter: Derk Pik
Pythagoras Profielwerkstuk Prijs

Een belangrijk onderdeel van de docentendag is de uitreiking van de Pythagorasprijs voor het beste profielwerkstuk in de wiskunde. De prijs wordt voor de tweede keer uitgereikt. De drie beste leerlingen zullen een korte voordracht houden, waarna het publiek het beste, mooiste, meest interessante werkstuk mag uitkiezen.

De winnaar van de eerste profielwerkstukprijs was Eytan Cortissos van de Joodse scholengemeenschap Maimonides met optimale verdelingen van punten op een boloppervlak. De andere winnende kandidaten waren Fleur Piers en Romy Rouwendaal van het Kennemer College te Beverwijk met RSA-cryptografie en Rainier van Es van het Zwijsen College te Veghel met veeltermvergelijkingen. Alle drie kandidaten gaven glasheldere presentaties over hun onderwerp.

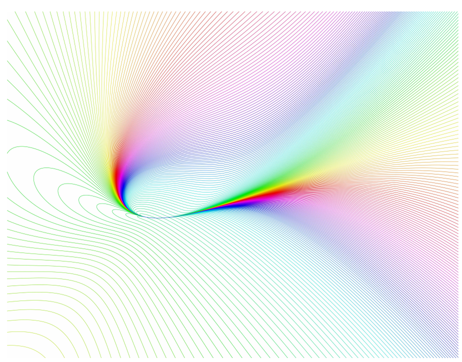
PhD Prize lectures, Wednesday 10:50-12:30 Atlas

On Wednesday morning there will be five lectures by candidates for the KWG PhD Prize. This prize is sponsored by Bronstee. The Prize ceremony will be held at the closing of the NMC.

Maarten Derickx (Universiteit Leiden)
Torsion points on elliptic curves over number fields

Barry Mazur famously classiefied which group structures can occur as the torsion subgroup of an elliptic curve over the rationals. Indeed he proved that among the infinitely many isomorphism classes of finite abelian groups there are only 15 which occur as a torsion group of an elliptic curve over the rationals. This work was later extended by Loïc Merel who showed that for every degree d there is a finite set of isomorphism classes of abelian groups that can occur as the torsion subgroup of an elliptic curve over number fields of degree d. However an explicit determination of these finite sets has up till now only been completed for degrees 1 and 2.

The main result is a complete classification of which primes can divide the group order for degrees up to and including 6. The result is obtained through a combination of theoretical and computational means. This is not only a huge step in the direction of determining all possible group structures of elliptic curves over number fields of small degree, but also has applications in solving certain generalized Fermat equations.



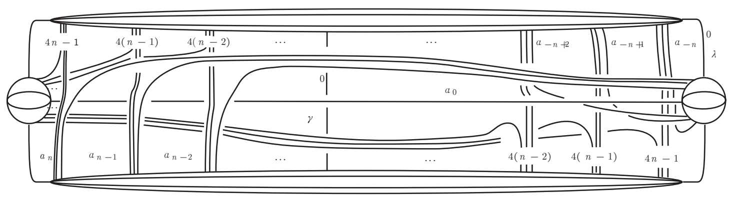
Ralph Klaasse (Universiteit Utrecht)
Constructing A-symplectic structures

Symplectic geometry has been very succesfully linked to the study of Lefschetz fibrations by the work of Gompf, Donaldson and others. This correspondence has been extended to other Lefschetz-type fibrations and geometric structures suitably generalizing the symplectic condition. Here one allows for more singularities to occur and considers closed two-forms whose lack of nondegeneracy is precisely controlled.

Poisson and generalized complex geometry provide further interesting classes of singular symplectic structures, instead emphasizing the bivector description of a symplectic form. Examples of this kind are log-symplectic and stable generalized complex structures, both of which are generically symplectic but degenerate on a submanifold of positive codimension. Crucially, these structures become smooth when lifted to an appropriate Lie algebroid A, there defining a genuine symplectic structure.

In this talk, we discuss a general procedure to construct such A-symplectic structures by extending Gompf–Thurston techniques to Lie algebroid morphisms and Lie algebroid Lefschetz fibrations. As an application we obtain both log-symplectic and stable generalized complex structures out of log-symplectic structures. In particular, we define a class of maps called boundary Lefschetz fibrations, and show they equip their total space with a stable generalized complex structure.

This is based on joint work with Gil Cavalcanti.

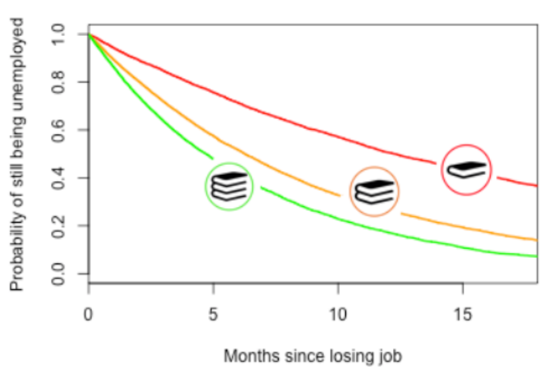


Sanne Willems (Universiteit Leiden)
Optimal Scaling of Ordinal Data in Survival Analysis

Studies often involve measurement and analysis of categorical data with nominal or ordinal category levels. Nominal categories have no ordering property (e.g. gender). Ordinal category levels, however, have an ordering (e.g. education level). When analyzing survival data with the Cox proportional hazard model to stimate the time to a certain event of interest (e.g. finding a new job), currently two methods can be chosen to include ordinal covariates.

One can use dummy covariates, as is done for nominal data. But due to the nominal interpretation, the ordering property of the categories may be lost. To keep the ordering property, one can use integer values for the category levels and interpret these as numeric values. However, due to the numeric interpretation, the property of equal distances between consecutive categories is introduced. This assumption is too strict for this data type; distances between consecutive categories do not necessarily have to be equal.

In this talk, we will give a short introduction to survival analysis and to our method that includes ordinal data in the Cox model without losing the ordering of category levels, or introducing equal distances between them. Simulation results show that this new method increases the model fit in case of ordinal data.



Erik Visse (Universiteit Leiden)
Explicit bounds on Brauer groups for Kummer surfaces

It is generally a difficult question, given a class of varieties, to describe their sets of rational points or even proving non-emptyness. One method makes use of the associated Brauer group.

In 2008, Skorobogatov and Zarhin proved that Brauer groups of K3 surfaces over number fields are finite, without making an effective statement about their size. In joint work with Victoria Cantoral-Farfán, Yunqing Tang and Sho Tanimoto, we restrict ourselves to the subclass of so-called Kummer surfaces.

The Brauer group falls apart in two parts: the algebraic part which is often easy to determine, and the transcendental part which is more difficult to handle. Our main theorem accomplishes just that: using some numerical data associated to a Kummer surface as input, we give a formulaic bound on the size of the transcendental part.

My plan for the talk is twofold: I will clarify the role of the Brauer group using some accessible examples, therewith motivating my interest in them. Afterwards, I will sketch the line of thought for the proof of our main result, focussing on how the relevant parameters enter the field of play.

Frans de Ruiter (Universiteit Tilburg)
Duality in two-stage linear and nonlinear adaptive robust optimization

We derive and exploit duality in general two-stage adaptive linear optimization models. The new dual differs from the primal in its structure and dimensions. We show that by using affine policies we obtain the same solutions for the primal and dual model, but the dual can be solved an order of magnitude faster than the primal formulation. For the nonlinear case we show that problems that were seemingly intractable before, do have a tractable dual formulation. Finally, we show how the dual model can be used to provide lower bounds for the optimal value of the adaptive optimization problem.

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